FUSIBLE BUNG FOR LIQUID TANKS

TECHNICAL FIELD

[0001] This invention relates to fusible bungs for tanks and other receptacles for containing fluids. More particularly, it relates to a bung for relieving gas or air pressure in such a receptacle in response to elevated temperature.

BACKGROUND OF THE INVENTION

[0002] There are many types of tanks for storing or transporting industrial liquids such as paint and solvents which require safeguards against excessive air or gas pressure in the tank. Such a condition, for example, may arise when a tank containing liquid and air is subjected to increasing ambient temperature.

[0003] As disclosed and claimed in my U.S. Patent No. 5,573,135 granted November 12, 1996, it is already known to provide tanks with a manually removable pressure relief bung in the top of the tank and/or in a manhole cover and/or in a mixer mounting cover which will relieve the tank pressure to the atmosphere through vent holes in the bung. In this, the vent holes will be fully opened in about one full turn of the bung in less time than the minimum time required to release the mixer cover or the manhole cover or the bung itself from the tank. Accordingly, when the pressure relief bung is opened before either the mixer cover or the manhole cover is disconnected from the tank, the risk of either cover being blown off the tank is greatly diminished.

[0004] There is a need for providing some tanks of the type described above with a bung which will function to relieve pressure in the tank in response to temperature. It is desirable in some applications to provide pressure relief in response to excessive temperature by means combined with manually removable pressure relief bung as described in the aforementioned U.S. patent 5,573,135. Alternatively, in some applications it may be desirable to provide a bung which relieves excessive tank pressure in response to temperature as its sole function.

[0005] In some applications it is desirable to provide such tanks with a bung with means for relieving excessive gaseous pressure from the tank independently of the temperature at the bung. As disclosed in U.S. Patent No. 5,240,027, it is already known to provide a bung with both pressure responsive and temperature responsive relief devices for containers such as storage tanks and the like.

SUMMARY OF THE INVENTION

[0006] The invention provides a fusible bung for use in connection with tanks and other liquid containers, including both portable and non-portable containers. In accordance with one aspect of the invention, the fusible bung includes first and second walls and a fusible link. The first and second walls preferably comprise concentric, cylindrical exterior and interior walls, respectively, with the first wall having threads or some other fastening feature by which the bung can be mounted to the tank. A vent passage is located between the two walls and is closed off at one end by the fusible link. The walls and fusible link can all be formed as a unitary body of polymeric material such as HDPE. The bung can also include a sealing ring located at the exterior wall so that, when attached to an opening in the tank, the bung provides a gas-tight seal of the opening. Upon experiencing elevated temperatures that could create increased pressures within the tank, the fusible link softens and/or melts to the point of rupture so that the gas pressure within the tank can be relieved through the vent passage.

[0007] The central region within the interior wall can be closed off by a cover member that can be unitary with the second wall. Alternatively, the interior wall can include a threaded bore for receiving a separate relief valve, such as a pressure and/or vacuum relief valve.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Preferred exemplary embodiments of the invention will hereinafter be described in conjunction with the appended drawings, wherein like designations denote like elements, and wherein:

[0009] Figure 1 is a top plan view of a first embodiment of the fusible bung of this invention.

[0010] Figure 2 is a cross-sectional view of the first embodiment in a typical installation.

[0011] Figure 3 is an exploded view of a second embodiment of the fusible bung of this invention in a typical installation, and

[0012] Figure 4 is a side elevation view of the fusible bung of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0013] Referring now to the drawings, illustrative embodiments of the invention are shown in a fusible bung constructed as a unitary body of polymeric material such as high density polyethylene (HDPE). In a first embodiment, the fusible bung is adapted to relieve container pressure at a predetermined temperature. In a second embodiment, the fusible bung incorporates a pressure relief valve and is adapted to relieve container pressure at a predetermined pressure value or at a predetermined temperature. It will be appreciated as the description proceeds that the fusible bung of this invention may be utilized in a wide variety of applications and may be realized in different embodiments.

[0014] The fusible bung of this invention is especially adapted for use as a pressure relief device for liquid containers such as portable liquid mixing tanks of the type described above with reference to U.S. Patent No. 5,573,135. The entire disclosure of that patent is hereby incorporated by reference.

[0015] As shown in Figures 1, 2 and 4, the fusible bung 10 is adapted for threaded connection with a threaded bung flange 12 which is suitably formed in or mounted to a top wall or cover 14a of a tank 14. In the illustrative embodiment, the bung 10 is formed of a polymeric material, preferably a high density polyethylene (HDPE) material. The bung is preferably formed by injection molding as a unitary body. In the illustrative embodiment, the bung 10 is adapted to sealingly close the opening 13 of the bung flange 12 which is provided in the cover 14a.

[0016] The fusible bung 10 comprises a cylindrical exterior wall 18 which has an open lower end 22 for communication with the opening 13 formed by the bung flange 12. A male thread 24 on the outside of the cylindrical wall 18 is adapted to engage

the threaded bung flange 12. Bung 10 also comprises a cylindrical interior wall 18a which is closed at its upper end by a cover member 16 disposed within the interior wall 18a and closing the upper end thereof. The interior wall 18a is shorter than the wall 18 and provides a vent passage 15 which extends from the tank opening 13 to a venting fuse 20 for venting the tank 14 to the atmosphere. The venting fuse 20 comprises a thin, annular ring which is unitary with the walls 18 and 18a and constitutes a fusible link which will be described in detail below.

[0017] At the upper end of the fusible bung 10, the outside diameter of the cylindrical wall 18 is enlarged and forms an annular shoulder 26 which extends radially outwardly. The shoulder 26 is provided at its outer periphery with a set of four tool receiving notches 28 which are equally spaced around the circumference of shoulder 26. Each tool receiving notch has an axially extending side wall 32 with a flat bottom 34. The set of notches 28 are adapted to collectively receive a set of four drive teeth of a wrench for tightening and loosening the fusible bung in its threaded connection with the bung flange 12.

[0018] As shown in Figure 2, a preformed flat-sided sealing ring 36 of generally rectangular cross section is disposed in an annular recess 38 extending around the exterior of wall 18 adjacent the outer end of the thread 24. When the bung 10 is tightened into the bung flange 12, one flat side of the sealing ring 36 is seated against an annular inner rib 42 of the shoulder 26. The opposite flat side of the sealing ring 36 is thus seated against the annular outer surface of the bung flange 12.

[0019] Preferably, the sealing ring 36 is held captive on the bung by a mechanical interlock provided by the annular rib 42 and the annular recess 38 on the outside of wall 18. This mechanical interlock is formed by inserting the preformed sealing ring 36 into the mold cavity in which the fusible bung is molded. The preformed sealing ring 36 has an annular groove corresponding to the annular rib 42 and also has corners with a radius corresponding to the annular recess 38.

[0020] As shown in Figures 2 and 4, the fusible bung 10 is provided with a set of four safety vents 46 (only three shown). These vents are equally spaced on the wall 18 and each vent is elongated circumferentially. The vents are located axially relative to the threads on the bung so that venting of the tank begins within about ¼ turn of opening

rotation of the fusible bung. This safety vent structure is described in complete detail in the above cited U.S. Patent No. 5,573,135.

[0021] The venting fuse 20, referred to above, will now be described in greater detail. The venting fuse is unitary with both the inner cylindrical wall 18a and the outer cylindrical wall 18. It comprises an annular ring which has a thin axial dimension relative to the axial dimension of the wall 18 and relative to the axial dimension of the wall 18a. The thickness of the venting fuse 20 is 0.04" whereas the axial length of the interior wall 18a is 0.625" and that of the exterior wall 18 is greater. The axial thickness of the fuse 20 is less than about 1/15 of the axial length of the exterior cylindrical wall 18 and interior cylindrical wall 18a. The venting fuse 20 is thus adapted to melt more quickly than the walls 18 or 18a in response to an ambient temperature above the melting temperature of the HDPE. Accordingly, if the ambient temperature rises above the melting point of HDPE, the venting fuse 20 will melt and rupture while the walls 18 and 18a remain intact. The time lapse between the occurrence of the melting temperature and rupture of the fuse will vary in accordance with the ensuing temperature and pressure values. When a rupture of the venting fuse 20 occurs the gaseous pressure in the tank is vented to the atmosphere.

[0022] In general, the venting fuse 20 must rupture and thereby relieve tank pressure before it reaches a value at which any other pressure sustaining element of the tank is ruptured. The tank pressure will increase as the ambient temperature increases. When the ambient temperature reaches the melting point of the fuse 20, there will be a time delay before the fuse ruptures and relieves tank pressure. The amount of time delay will depend upon the values of both temperature and pressure.

[0023] Tests were conducted on samples of the fusible bung of this invention for studying the effect of the dimensions of the venting fuse 20 and the internal pressure of the test vessel on the temperature at which the internal pressure is relieved by the fusible bung. As shown in Table I below, the same test was performed on five different specimens numbered 1-5. All of the specimens were of the same structure except that each specimen had a fuse of dimensions different from the other specimens. In the test procedure, each specimen was installed on a pressure vessel which was disposed inside a test oven adapted to maintain a preset temperature of fixed value above the melting point of HDPE (about 270°F) for each test specimen.

The pressure vessel was connected to an air compressor for maintaining a pre-determined pressure inside the test vessel throughout the test. In the conduct of the test for each test specimen, the oven temperature was allowed to increase from room temperature toward the preset temperature until the venting fuse ruptured and relieved the pressure in the test vessel to the ambient air pressure. For each test specimen, the total time lapse from start to pressure relief was recorded.

[0024] The small margins between the relief temperatures of the specimens indicated that the venting fuse dimensions do not have a significant effect on the relief temperature of the fusible bung provided that it is thin enough relative to its supporting structure so that it melts and ruptures before its supporting structure. It was observed that the gauge pressure of the test vessel dropped instantaneously upon the occurrence of pressure relief. The test specimens all showed signs of rupture across about two-thirds of the circumference of the venting fuse on the inner part of the fuse surrounding the interior wall of the fusible bung. The actual pressure outlet was an opening on the ruptured circumference of each venting fuse.

[0025] Table I - Determination of Relief Characteristics of the Fusible Bung using Various Fuse Dimensions and Pressures

TEST Specimens	Fuse Dimensions (in.) Y (thickness)	X (width)	PRESSURE (PSI)	PRESET TEMP.	RELIEF TEMP. (°F)	TOTAL TIME TO RELIEF (MINUTES)
1	0.02	0.25	6	350	338	38
2	0.02	0.312	6	350	340	37:25
3	0.015	0.312	6	350	336	34:07*
4	0.04	0.312	6	350	345	-----
5	0.02	0.312	8.5	350	343	35

* - Oven was warm at beginning of test.

[0026] Based on the test results shown in Table I above, the dimensions of the venting fuse of specimen number 4 was used as the standard dimensions of the venting fuse in each of the test specimens in the additional testing described below.

[0027] Tests were conducted on specimens numbered 6-10 (see Table II below) to study the role of temperature and pressure on the venting characteristics of the fusible bung of this invention. In the testing of these specimens, the oven temperature was raised to various pre-determined temperature ranges and maintained within the limits of the specified range. In the test procedure, the internal pressure of the test vessel

was manually controlled periodically to reset the pressure to a predetermined constant value. The trends in Table II show that as the temperature range was increased beyond the melting point of HDPE (about 270°F) there was a decline in the relief times and the test vessel pressure dropped faster after relief.

[0028] Table II - Determination of Relief Times of the Fusible Bung at Various Temperature and Pressures

Test #	Tested Temp. Range (T1°F- T2°F)	Pressure (PSI)	Time to Reach T1 (Minutes)	Relief Time (Minutes)	Comments
6	290-295	6	27:30	23	Instant Drop of Pressure
7	290-295	8.5	26	19:50	Instant Drop of Pressure
8	275-280	6	25:40	25	Gradual Drop of Pressure
9	275-280	6	25:40	27:40	Gradual Drop of Pressure
10	260-265	6	22	46:30	Slowest Drop of Pressure

[0029] A test was conducted on the specimen number 11 (see Table III below) to determine whether the fusible bung would relieve pressure at a temperature below 220°F. According to U.S. Department of Transportation (DOT) regulations, the fusible bung, for certain applications, should not relieve pressure below 9 psi at a temperature of 220°F.

[0030] The results of this test, as shown in Table III, shows that the test specimen withstood up to 9 psi at 220°F for a prolonged period of time.

[0031] Table III - Determination of Fusible Bung Characteristics at 220°F

Test #	Tested Temp. Range (T1°F- T2°F)	Pressure (PSI)	Time to Reach T1 (Minutes)	Relief Time (Minutes)	Comments
11	220-225	9	18	2:02 (No Relief)	Elevated Groove Layer

[0032] A test was conducted on test specimens 12, 13 and 14 (see Table IV below) to determine the performance of the fusible bung at room temperature and under conditions of high pressure. In this test, the pressure regulator was set to the test pressure level. These results show that the venting fuse is capable of functioning at room temperature under pressures up to at least 84 psi and possibly even up to 102

psi, although leaking in the seal area did occur at this upper pressure in another, similar test.

[0033] Table IV - Hydrostatic Test of the Fusible Bung

Test #	Pressure (PSI)	Torque (ft-lbs)	Room Temp. (°F)	Duration (Minutes)	Results
12	102	30	75	31	No Leaks-Deformed Groove Layer
13	81	----	70	25	No Leaks – Slight Elevation of Groove Layer
14	84	30	75	31	No Leaks – Slight Elevation of Groove Layer

[0034] The illustrative embodiment of the invention as described above exhibits sufficient structural integrity so that it can withstand operation within the normal range of pressure and temperature without melting of the venting fuse 20 before the temperature becomes excessive. On the other hand, the venting fuse does melt and produces venting of the tank within an accepted time period after the ambient temperature reaches the melting point of the fuse.

[0035] A second embodiment of the fusible bung of this invention is shown in Figure 3. This embodiment of the invention differs from that of Figures 1, 2 and 4 in that a pressure vacuum relief valve 50 is combined with the fusible bung to provide for pressure or vacuum relief when the tank pressure reaches a predetermined value above or below the atmospheric pressure. In this embodiment, the structure and operation of the fusible bung is the same as in the first embodiment except for the addition of the pressure vacuum relief valve 50. Accordingly, only these changes will be described below. The same reference characters will be used for the same parts in both embodiments of the fusible bung and, for modified parts a prime symbol will be added to the reference characters of the embodiment. For added parts, additional reference characters will be used.

[0036] As shown in Figure 3, the pressure vacuum relief valve 50 is combined with a modified fusible bung 10'. The fusible bung 10' is the same as fusible bung 10 except that the interior wall 18a' is formed with a threaded bore 48 (instead of the cover 16 of Figure 2).

[0037] The relief valve 50 has a valve body 52 provided with external threads 54 which mate with the threaded bore 48 for providing a fluid tight seal between the valve 50 and the fusible bung 10'. The valve 50 is of conventional design for providing both pressure and vacuum relief at preset pressures above and below atmospheric pressure. Alternatively, the relief valve could provide either pressure relief or vacuum relief instead of both functions.

[0038] Although this invention has been described with reference to particular embodiments, it is not to be construed in a limiting sense. Many variations and modifications will now occur to those skilled in the art.

[0039] As used in this specification and appended claims, the terms "for example" and "such as," and the verbs "comprising," "having," "including," and their other verb forms, when used in conjunction with a listing of one or more components or other items, are each to be construed as open-ended, meaning that that the listing is not to be considered as excluding other, additional components or items. Other terms are to be construed using their broadest reasonable meaning unless they are used in a context that requires a different interpretation.